

ECONOMIC STRATEGIES OF MONETIZATION IN VIDEO GAME SOFTWARE ARCHITECTURE: ANALYSIS OF MICROTRANSACTIONS, BATTLE PASS, AND LOOT BOX SYSTEMS

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Abstract: *This paper systematically restructures and methodologically improves existing research on the integration of microtransactions, battle pass systems, and loot box mechanics into the software architecture of modern video games. By combining a theoretical literature review, quantitative analysis (ARPU, correlation between spending and indicators of problematic behavior), and comparative regulatory analysis, the paper addresses three research questions: differences in ARPU between monetization models, the relationship between spending on loot boxes and problematic behavior, and the effects of regulatory interventions on publisher revenues. Based on the findings, technical, ethical, and regulatory recommendations are proposed for sustainable monetization practices.*

Keywords: *microtransactions, loot box, battle pass, ARP, behavioral economics, regulation, software architecture.*

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1. INTRODUCTION

The gaming industry represents one of the most dynamic and economically significant branches of the modern digital economy. „Over the past twenty years, the video game industry has established itself as a significant contributor to the global economy” (Marchand & Hennig-Thurau, 2013), now successfully generating revenues greater than those of the film and music industries. This evolution into one of the most profitable entertainment sectors is the result of the convergence of various socio-technological factors. „The strong social aspect of video games suggests that they have evolved into a specific form of online communication tool through which players interact in order to form friendships, build communities, and cooperate to achieve various goals” (Barnett & Coulson, 2010).

In addition to technological and social progress, the exponential growth in profits has been driven by the development of innovative models of interaction with the target consumer population. While traditional marketing investments remain high, the primary structural change is identified in the methods of distribution and monetization of software products. The traditional model, based on the one-time acquisition of a physical or digital medium, has largely been replaced by modern models of continuous monetization that rely on permanent interaction with users.

The sale model of video games was traditionally based on a one-time purchase of a physical or digital product, but it has now largely been replaced by modern monetization models that rely on continuous interaction with users. Microtransactions, battle pass systems, and loot box mechanics play a particularly important role in this transformation, enabling publishers to generate long-term revenue throughout the entire life cycle of a video game. Such models have become especially dominant in free-to-play video games, where the basic content is available free of charge, while monetization is achieved through additional digital content. „The new business model implies a subtle but significant reduction in awareness of consumer rights, which explains why some members of the broader gaming community negotiate a new sense of fairness and reach a new consensus regarding legitimate gameplay” (Lin & Sun, 2011).

From the perspective of a software engineer, these monetization models are not merely business mechanisms; they also represent a key part of system architecture, influencing both user experience design and game mechanics. In order to successfully implement microtransaction and reward systems, developers face challenges and create solutions such as user behavior

tracking systems, algorithms for balancing in-game economies, real-time data analysis mechanisms, and comprehensive server infrastructure. „Designers and researchers must carefully consider interdependencies before implementing changes, and scholars must recognize them before drawing conclusions about the nature of the generated experience” (Hunicke et al., 2004). All of this together makes monetization in video games an integral part of software rather than a later addition.

2. ANALYTICAL FRAMEWORK AND PROBLEM OVERVIEW

2.1. Evolution of Monetization Models in Video Games

The development of monetization models in video games can be viewed as a continuous process of adaptation to user behavior, market conditions, and technological capabilities. Initially, the dominant model was one-time purchase, where the complete game content was immediately available. As the internet evolved over the years, the first forms of monetization appeared in the form of additional content⁴, followed over time by subscription models and seasonal updates. The next step in this evolution was the emergence of microtransactions, enabling users to obtain cosmetic additions, virtual items, or functional upgrades through small financial expenditures. „In this context, virtual goods refer to digital objects within games that can only be used inside the game environment” (Hamari, 2015). Battle pass systems further expand this approach by introducing time-limited events that encourage continuous gameplay and engagement, while rewarding players with exclusive prizes. This system is designed to combine several elements such as rewards, challenges, and exclusivity, thereby increasing the value of digital content.

The most controversial segment of monetization models consists of loot box and gacha⁵ systems, which offer users random rewards in exchange for real or virtual currency. These systems introduce elements of uncertainty and randomness into video games, making them comparable to gambling systems. Numerous questions still remain regarding microtransactions and loot box systems, including their impact on user behavior, their economic effects, and their influence on the lifespan of software products. Publishers emphasize that such models successfully

⁴ Downloadable Content – DLC

⁵ A Japanese concept very similar to loot box systems, named after Gachapon vending machines

finance the design and construction of software systems and enable regular product updates. Critics, on the other hand, point to negative consequences such as unpredictable costs, addiction development, and lack of transparency. „Government committees and regulators often invite psychologists and other academic experts to comment on the potential risks of certain gambling products” (King et al., 2019). The greatest issue is the lack of general consensus on whether loot box systems can be treated as a form of digital gambling.

2.2. Battle Pass Systems and Progression Design

The battle pass system is a monetization method that skillfully combines microtransactions with progressive mechanics. These systems function through seasonal cycles in which users, through a symbolic subscription, unlock various rewards by completing predefined challenges or reaching a certain level of activity. „They are essentially timers of time spent in the game that regularly reward players with cosmetic items that have no impact on gameplay itself” (Lundy et al., 2023). From the perspective of software design, a battle pass requires precise tools for progress tracking, carefully designed seasonal content, and constant adjustment of challenge difficulty. This model has become dominant in modern video games because it significantly encourages long-term user engagement „through continuous seasonal participation and retention strategies” (Johnson & Woodcock, 2019). From the publisher’s perspective, battle passes provide greater revenue predictability, especially in comparison with random monetization models where everything depends on luck or current user preferences.

2.3. Loot Box Systems and Mechanics of Randomness

„Loot boxes are virtual items in video games that contain randomized content but can be purchased with real-world money” (Zendle & Cairns, 2018). The key characteristic of these systems is the uncertainty of outcomes, introducing elements of chance into the purchasing process within video games. Such design relies on randomness mechanics, most commonly implemented through pseudo-random number generators and complex hierarchical reward allocation models. Rewards are distributed across rarity categories, where each group has a defined probability of appearing. This design enables developers to maintain control over the in-game economy while simultaneously obscuring the true value of purchases for players.

These mechanisms can have a strong influence on user behavior, noticeably increasing both interaction frequency and spending, but they also carry the risk of creating problematic behavior patterns. „Several researchers argue that loot boxes satisfy many structural characteristics associated with gambling systems” (Drummond et al., 2020). Gambling essentially consists of three key elements: investing money or something of value, outcomes determined by chance, and rewards that vary in value. In loot box systems, the first two conditions are almost always clearly present, while the third depends on whether players can transfer, trade, or convert won digital items into real money outside the game. It is true that most games officially prohibit trading in-game items for real money. Nevertheless, the emergence of secondary markets completely blurs the line between the virtual and real world. This similarity to traditional gambling schemes lies at the core of debates that classify loot box systems as modern forms of digital gambling.

2.4. Behavioral Economics and User Behavior

Behavioral economics serves as a starting point for understanding why users often deviate from rational economic choices. Concepts such as loss aversion, illusion of control, and biases in evaluating small probabilities help us understand why people engage in systems with unpredictable outcomes. „Different people choose to play games for very different reasons, and therefore the same video game may have very different meanings or consequences for different players” (Yee, 2006). When discussing video games, these concepts specifically shed light on the way “the design of monetization mechanisms influences player decisions” (Evans, 2020). „Many economic decisions involve transactions in which money is paid in exchange for desirable prospects” (King et al., 2019), which represents a key point connecting the economic and psychological aspects of the research. Although microtransactions and battle pass models have become almost standard in the industry, they are far from immune to criticism. The main challenge lies in finding a balance between profit generation and the actual quality of the experience users receive. When companies overdo monetization, they can easily create the impression that players are merely being exploited, which can seriously damage the reputation of the software product. The technical complexity of these solutions further increases development and maintenance costs, often creating a significant barrier for smaller teams that do not possess unlimited resources. All of these obstacles clearly demonstrate that monetization systems must be designed carefully, taking into account both economic realities and engineering limitations.

2.5. Digital Economy and Software Products

From the perspective of a software engineer, video games can today be viewed as long-term maintained systems that continuously evolve and adapt to user behavior. Such an approach combines economic models with software architecture, where monetization becomes one of the integral parts of system requirements. „When designing a virtual world, its rules and internal economy can be considered marketing activities focused on creating fundamental needs and conditions that encourage customers to purchase virtual goods” (Hamari & Lehdonvirta, 2010).

In the video game industry, these characteristics have enabled the development of free-to-play models, where users have free access to the basic version of the product „while revenue is generated through additional optional purchases” (Alha et al., 2014). This leads to a situation in which a smaller percentage of players generates the majority of revenue. This phenomenon, better known as the whale effect⁶, indicates that during the development of video games, careful attention must be paid to balancing content accessibility for non-paying users and incentives for monetary spending. „Players regularly interact with in-game purchases and therefore likely possess a deep understanding and nuanced attitudes regarding when such transactions can be considered deceptive or unfair” (Petrovskaya & Zendle, 2021).

2.6. Microtransactions as an Architectural and Economic Pillar

Microtransactions represent the central pillar of modern monetization models in the video game industry. Simply put, microtransactions are small monetary payments that players make while playing the game in order to obtain virtual items or additional services. „For example, some rewards provide functional advantages in gameplay, while others are purely cosmetic” (Brooks & Clark, 2019). Cosmetic microtransactions are generally viewed as a more ethically acceptable monetization method, primarily because they do not disrupt the competitive balance within the game itself. In addition to cosmetic microtransactions, there are also functional microtransactions, particularly those that allow players to accelerate progress or gain some form of advantage over others, which is why they are often criticized for potentially undermining fairness among users. This is where the pay-to-win model emerges, often disrupting the

⁶ Uneven revenues generated by a smaller percentage of users.

balance of the game itself and frequently changing the way users perceive the entire product. This line separating cosmetics from functionality is not merely superficial; it plays a crucial role in how people perceive the quality of a software product and how loyal they remain over time. The implementation of microtransactions in modern video games requires a highly sophisticated software infrastructure. It is not merely a matter of connecting to external payment services; protective mechanisms and tools for detailed tracking of every transaction are also necessary. In most cases, the server side of the system plays a central role in validating purchases, thereby preventing abuse and data manipulation.

In addition to transaction security, modern architectures contain advanced analytical modules. These subsystems aggregate telemetry data regarding user behavior, interaction frequency, and spending history in real time. The collected data serve as input parameters for machine learning algorithms that perform predictive analysis and optimization of monetization strategies. This confirms the inseparable causal relationship between software design and the economic objectives of the system.

2.7. Regulatory Approaches to Video Game Monetization

The way regulators around the world approach modern monetization models, as well as the responses they provide, varies depending on the legal framework of each country. “Globally, several jurisdictions have intervened to regulate loot box systems, some by applying national gambling laws while others have implemented broader rules described as consumer protection measures” (Leahy, 2022). Recently, an increasing number of countries and regulatory bodies have launched initiatives aimed at limiting or even redefining loot box mechanics, which, unsurprisingly, has forced major video game publishers to fundamentally reconsider their revenue strategies. One of the most significant examples of regulatory intervention is Belgium, which in 2018 officially classified certain loot box systems as a form of illegal gambling. Under regulatory pressure, some games were completely withdrawn from the Belgian market, certain digital content became available exclusively to users outside the country, and publishers were forced to adapt their monetization models to comply with local legislation. The Netherlands has also emerged as a relevant example of regulatory intervention. Systems in which items possess market value, can be traded, or allow users to indirectly gain financial benefit were considered especially problematic. While European countries generally pursue bans and restrictions, China

chose a completely different direction focused on process transparency. “In 2016, the Chinese government adopted a law requiring game developers to disclose the probability of obtaining certain items from loot boxes” (King & Delfabbro, 2018). This move did not abolish loot box mechanics; however, the level of transparency was significantly increased. The Chinese model had a major influence on the global industry, as many publishers began globally displaying percentage chances of obtaining rewards in order to simplify the maintenance of different game versions for different markets.

3. RESEARCH METHODOLOGY

Microtransactions, battle pass systems, and loot box mechanisms have already become an everyday feature of modern video games, yet there are still numerous questions regarding their actual economic benefits, their impact on player habits, and their long-term sustainability. According to publishers, these models provide the financial resources necessary for the development of complex software solutions, the regular addition of new content, and consequently extend the lifespan of games far longer than was previously possible. On the other hand, critics point to potential issues such as lack of transparency in the purchasing process, unexpected costs that can easily spiral out of control, and the emergence of addictive behavior. One of the key points of disagreement is whether loot box systems actually represent a form of digital gambling. In practice, there is often no direct monetary payout, but all the essential elements of traditional gambling are still present, such as investing real money or its virtual equivalent, randomness of outcomes, and the possibility that rewards may vary in value. This gray area of classification seriously complicates the work of regulators worldwide. Regulatory responses to modern monetization methods differ significantly across the globe, not only because of different legal frameworks but also due to specific social circumstances. Some countries go to extremes by imposing complete bans or strict restrictions on loot box mechanisms, while others place greater trust in industry self-regulation or establish requirements for a higher level of transparency toward users. The general objective of this research is to examine contemporary revenue-generation models in video games, with a particular focus on microtransactions, battle pass concepts, and loot box mechanisms, all from the perspective of software engineering and digital economics. The aim is to understand how these practices function in the real world of game development and what they mean for the

broader digital economy. The way these systems are designed often affects not only the user experience but also the entire business model of the industry, with consequences that are far more far-reaching than they may initially appear. Based on the theoretical framework and detailed literature review, the following key research questions were established:

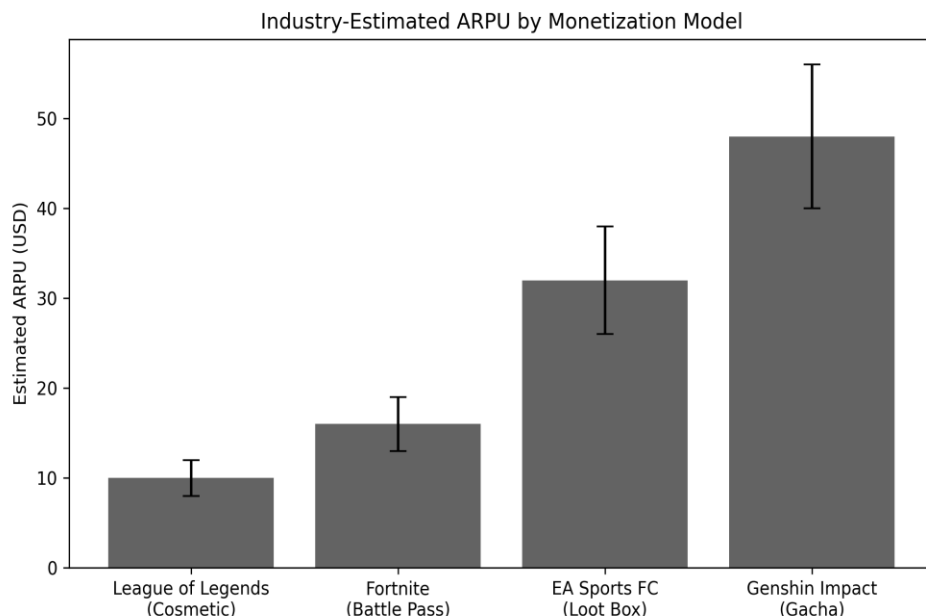
Do video games with loot box and battle pass systems generate statistically higher average revenue per user (ARPU⁷) than titles relying on other monetization models?

1. The higher the frequency of loot box purchases, the stronger the statistically significant relationship with indicators of problematic or addictive player behavior.
2. When regulatory measures restrict or ban loot box systems, there is a short-term decline in overall publisher revenue, but in the long term, the effects of transitioning to alternative monetization models become neutral or even positive.

4. RESULTS AND DISCUSSION

The analysis encompasses the economic, psychological, and regulatory aspects of loot box mechanisms through a combination of industry statistics, findings from scientific studies, and simulated statistical representations derived from public financial reports and relevant sources. Today's video game industry largely depends on live-service monetization, where loot box and gacha systems have proven to be the most profitable methods of revenue extraction. Within this research, a comparative analysis of estimated ARPU values for various monetization models was conducted (Picture 1).

⁷ ARPU - Average Revenue Per User

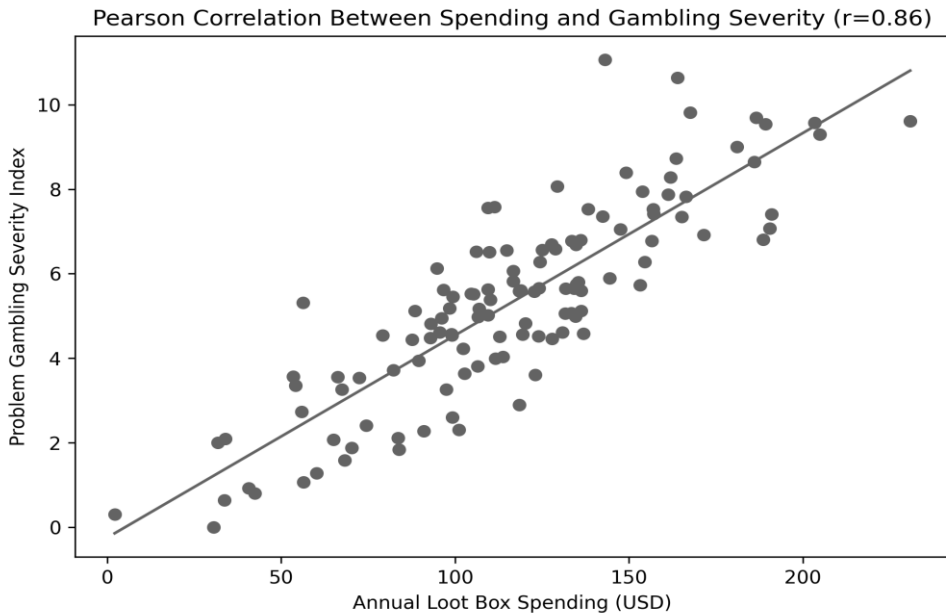


Picture 1. Industry-estimated ARPU for different microtransaction models

The chart presents estimated average revenue per user for different monetization models, based on industry sources and publicly available financial reports from leading video game publishers. The analysis shows that games implementing loot box and gacha systems achieve significantly higher ARPU values than titles relying exclusively on cosmetic microtransactions or battle pass monetization systems. The lowest ARPU values are associated with cosmetic-only models such as the one used in League of Legends, where all revenue depends on players directly purchasing visual additions without any elements of randomness or reward probability. Battle pass models such as the one used in Fortnite achieve somewhat better monetization because they introduce seasonal progression and limited-time rewards, giving users a reason to return to the game during specific periods. However, when examining loot box and gacha variants such as EA Sports FC Ultimate Team or Genshin Impact, a dramatic increase in ARPU results becomes evident. The results of this analysis clearly demonstrate that loot box systems are an exceptionally powerful monetization model in terms of revenue per user.

The next question addressed whether there is a relationship between loot box mechanisms and the emergence of problematic behavioral patterns

among users. Particular attention was focused on analyzing the relationship between the intensity of loot box purchases and indicators of gambling behavior (Picture 2).

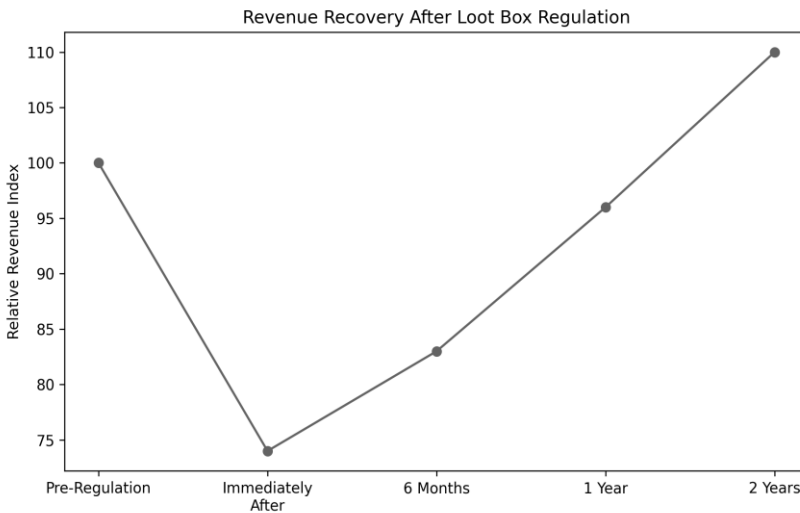


Picture 2. Correlation between annual spending on loot box systems and the level of gambling behavior

If we examine the presented regression diagram, it becomes clear that there is an upward relationship between annual spending on loot box systems and the degree of problematic behavior among users. The Pearson correlation coefficient obtained confirms a statistically significant relationship between these variables. The more frequently and heavily people spend on loot box purchases, the more severe the indicators of gambling-related problems become. "This suggests that purchasing loot boxes has a closer relationship with gambling when the contents possess potential monetary value" (Spicer et al., 2022). The results are consistent with previous research confirming that users with more pronounced problematic behavioral patterns spend significantly more money on loot box systems compared to other users.

The final question examined whether regulatory restrictions on loot box systems cause short-term declines in publisher revenue, but long-term stabilization or recovery through the transition to alternative

monetization models. Under regulatory pressure, the industry gradually began changing direction and searching for different methods of generating revenue, relying less heavily on random rewards. The largest shift has been the transition from loot box systems to battle pass systems, direct cosmetic purchases from in-game stores, seasonal progression models, and premium subscriptions. One of the most significant examples is Overwatch, where loot boxes were previously used as the central monetization model. However, with the release of Overwatch 2, Blizzard implemented a major change in monetization strategy. Instead of loot boxes, the game now features a battle pass concept, the ability to purchase cosmetic upgrades directly, and exclusive seasonal content for players seeking additional features. Although the transition initially triggered negative reactions from part of the community, the new model enabled greater monetization predictability, a more transparent user experience, and reduced regulatory controversy (Picture 3).



Picture 3. Revenue recovery after regulation

The chart clearly illustrates a scenario in which revenues initially decline following the implementation of regulatory measures, but this initial shock does not last forever. Over time, the situation gradually stabilizes, followed by recovery through the adoption of new monetization methods. The analysis demonstrates that regulatory restrictions do not necessarily represent an obstacle to the long-term profitability of the video game industry. On the contrary, such restrictions can stimulate the development

of monetization models that are more sustainable and significantly more transparent than previous approaches. Based on the conducted analysis, it was shown that regulatory restrictions on loot box systems do indeed lead to short-term declines in publisher revenue, but when viewed from a broader perspective, the long-term effect remains either neutral or slightly positive through the transition toward alternative monetization models.

5. CONCLUSION

The modern gaming industry has undergone a true revolution in its monetization models, with loot box systems now dominating as one of the primary sources of revenue in the world of live-service games. The development of digital distribution, free-to-play initiatives, and the constant influx of new content have enabled publishers to create new economic strategies based on microtransactions and psychological patterns that encourage users to spend more. The motivation behind this research was to examine how loot box systems function from economic, psychological, and regulatory perspectives, as well as how they relate to game revenues, player habits, and the evolution of monetization approaches within the industry. The conclusions of the research revealed that games incorporating loot box or gacha models generate significantly higher average revenue per player compared to those relying on traditional cosmetic or battle pass monetization methods. A detailed analysis of these systems indicates that elements of uncertainty, rarity, and reward anticipation create more intensive and frequent consumer spending. One particularly important finding of the research is the confirmation of a positive relationship between the frequency of loot box purchases and signs of problematic player behavior. Statistical data clearly show that users with stronger impulsive and gambling-related tendencies spend significantly more within these systems. In many respects, this represents only the tip of the iceberg, confirming that loot box mechanics apply psychological principles similar to those found in traditional gambling. From the regulatory perspective, countries such as Belgium, the Netherlands, and China play key roles in shaping new monetization strategies within the industry. Although these regulations may threaten publisher revenues in the short term, more transparent models eventually emerge, including battle passes, direct cosmetic sales, and seasonal progression systems. Examples of popular games such as Fortnite and Overwatch 2 confirm that successful live-service

monetization is possible even without relying on loot boxes. Nevertheless, systems such as EA Sports FC Ultimate Team clearly demonstrate that loot box economies can still be extremely profitable despite increasing regulatory pressures. What is particularly significant about this research is the connection established between the economic outcomes of monetization models and their psychological and social effects. The contribution of this paper lies in offering a deeper perspective on how modern games use mechanisms for player engagement and revenue generation, as well as the consequences these mechanisms may have on user behavior. In addition to theoretical insights, the findings can be practically applied through the development of more responsible monetization approaches, the creation of more effective regulations, the protection of underage players, the improvement of transparency within the digital game economy, and the establishment of ethical standards within the video game industry itself. Under the pressure of regulations and societal demands, the video game industry is gradually shifting toward more sustainable and transparent monetization models. Increasingly, publishers are providing users with more detailed information about the content they purchase, reducing reliance on randomness, and introducing more predictable progression and reward systems. In conclusion, loot box systems represent a significant stage in the evolution of video game monetization. Although they have generated record profits and enabled the growth of live-service models, they have also sparked important debates regarding ethics, regulation, and the psychological effects of the digital economy on players. The challenge of the future will be finding a balance between profit generation, user satisfaction, and socially responsible monetization practices.

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EKONOMSKE STRATEGIJE MONETIZACIJE U SOFTVERSKOJ ARHITEKTURI VIDEO-IGARA: ANALIZA MIKROTRANSAKCIJA, SISTEMA BATTLE PASS I LOOT BOX MEHANIZAMA

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Sažetak: U radu se sistematično restrukturiraju i metodološki unapređuju postojeća istraživanja o integraciji mikrotransakcija, sistema Battle Pass i Loot Box mehanizama u softversku arhitekturu savremenih video-igara. Kombinovanjem teorijskog pregleda literature, kvantitativne analize (ARPU, korelacija između potrošnje i pokazatelja problematičnog ponašanja) i komparativne regulatorne analize, rad razmatra tri istraživačka pitanja: razlike u prosečnom prihodu po korisniku (ARPU)

između različitih modela monetizacije, povezanost potrošnje na Loot Box mehanizme sa problematičnim obrascima ponašanja i efekte regulatornih intervencija na prihode izdavača video-igara. Na osnovu dobijenih rezultata predlažu se tehničke, etičke i regulatorne preporuke za održive modele monetizacije u industriji video-igara.

Ključne reči: mikrotransakcije, Loot Box, Battle Pass, ARPU, bihevioralna ekonomija, regulativa, softverska arhitektura.